

7. DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

The introduction of this section discusses the overall scope, format, and content of the Operable Unit (OU) 9-04 Feasibility Study (FS) Report, including assumptions developed to facilitate its preparation. Section 7.1 introduces the format of the comprehensive FS and the screening and disposition of OU 9-04 sites of concern. Section 7.2 lists assumptions developed in scoping the OU 9-04 FS. Section 7.3 presents the development of remedial action objectives (RAOs), identifies contaminants of concern (COCs), media and exposure pathways of concern, and identifies potentially applicable or relevant and appropriate requirements (ARARs). Section 7.4 discusses the areas and volumes of contaminated materials at OU 9-04 sites of concern. Section 7.5 presents the development of general response actions (GRAs).

7.1 Introduction

This section describes the scope and format of this comprehensive FS. The site screening process, whereby sites of concern were identified in the Remedial Investigation/Feasibility Study (RI/FS), is summarized. Since this FS is comprehensive, all WAG 9 release sites which were retained for further evaluation are addressed. The release sites were evaluated in Section 5 for human health risks and in Section 6 for threats to the ecological receptors.

7.1.1 Format of the Comprehensive Feasibility Study

WAG 9 will follow previously conducted Idaho National Engineering and Environmental Laboratory (INEEL) WAG examples of FSs. This strategy will save money and aid in combining the results of WAG s 1 through 9 into the WAG 10 document. The use of the previously conducted INEEL FS's is justifiable since the waste sites and contaminants are basically the same. Thus, the comprehensive OU 9-04 FS will be a focused FS, with a reduced number of remedial alternatives that would rely heavily on previous INEEL remedial responses at the and elsewhere to formulate remedial responses for OU 9-04 retained sites.

7.1.2 Site Screening Process

This FS is comprehensive, in that remedies are defined for all sources of contamination at OU 9-04 that exceed the upper limit of the NCP allowable risk range. ANL-W identified all the sites to be evaluated in the OU 9-04 RI/FS report in a screening process as shown in Table 3-2. The retained sites were then evaluated for the human health risks in the baseline risk assessment Section 5. The sites that were retained for evaluation in the FS because of human health risks are shown in Table 5-36. The retained sites were also evaluated for ecological concerns. The sites that are retained for evaluation in the FS because of ecological concerns are shown in Table 6-17. A brief summary of the WAG 9 release sites is described below. A more detailed evaluation of the screening process can be found in Section 3.1.

Thirty-seven release sites were initially identified at WAG 9 in the Federal Facility Agreement/Consent Order (FFA/CO). These were grouped into four OUs in the FFA/CO, and OU 9-04 was designated as the Comprehensive RI/FS of the entire WAG 9. Of the initial 37 sites, only seven release sites were retained for evaluation under the OU 9-04 comprehensive RI/FS. The other release sites were eliminated from further

evaluation because they either contained no source or the risks calculated in the Track 1 and Track 2 decision documents were less than 1E-6.

After completing the screening of the WAG 9 sites, ANL-W conducted a human health risk assessment on those retained sites. Tables 5-33, 5-34, and 5-35 show the exposure pathways and sites determined to present risks greater than 1E-06, 1E-04, or a hazard index (HI) greater than 1, respectively, for the human health risk assessment. These risks were then evaluated using a five step screening process as described in Section 5.11.2, which streamlined the sites and pathways to be evaluated in the FS. Table 7-1 shows the exposure scenario, exposure pathway, contributing contaminant of concern (COC), calculated COC risk, and exposure pathway risk for retained release sites that will be evaluated in the FS. This table specifically shows which contaminants and exposure routes are driving the risk assessment calculations.

The WAG 9 ecological risk assessment (ERA) evaluated all the FFA/CO sites and determined that 8 release sites have a potential source of contamination and/or a pathway to ecological receptors. These sites were evaluated using the general approach as discussed in VanHorn et al. (1995) and following guidelines proposed by EPA (EPA 1992). The results of the ERA evaluation of the remaining sites are presented as a range of hazard quotients (HQs) calculated for functional groups present as listed in Table 6-20. Due to the uncertainty in the ERA methods, HQs are used only as an indicator of risk and should not be interpreted as a final indication of actual adverse effects to ecological receptors. In addition, using the INEEL background concentrations for some inorganics results in HQs greater than 1. Table 7-2 shows the nine release sites which have a ecological HQ for metals greater than 1, which means they have the likelihood of presenting risk to ecological receptors. Only one site, ANL-35, had HQs greater than 1 for organics. As shown in Table 7-2, these organics are OCDD and HpCDD with HQs between 1 and 10. None of the nine sites evaluated for ecological receptors had a HQ for radiological receptors, as shown in Table 7-2. Based on the conservative nature of the HQs, ANL-W will only retain those WAG 9 sites for evaluation in the feasibility study that have HQs that are at least 10 times the HQ calculated using the INEEL or ANL-W specific background concentration. This will only eliminate three sites; ANL-05, ANL-29 and ANL-36 from being evaluated in the feasibility study. ANL-05 has one contaminant with HQ greater than 1, this contaminant is sodium and it is being eliminated because it is an essential nutrient and HQ is near the 10 times background level. Sites ANL-29 and ANL-36 have silver as the only contaminant at concentrations less than the ANL-W site specific concentration. Table 7-3 shows the five sites that were retained because of ecological risks.

7.1.3 Disposition of Sites

This FS is comprehensive, and the scope and approach of this report, developed in concurrence with the IDHW and EPA, are to address all OU 9-04 sites of concern. The overall approach is focused and uses the other prior INEEL actions to define potentially effective and implementable remedial process options, and to reduce the number of remedial alternatives for detailed analysis.

Not all OU 9-04 sites are currently amenable to remediation. OU 9-04 includes three sites which will be operational as long as the ANL-W facility has a mission. The proposals identified by DOE in the Land Use document state that the ANL-W facility will have an active mission for thirty years into the future (i.e., till 2027). These three sites are ANL-01 Industrial Waste Pond, ANL-09 Interceptor Canal, and ANL-35 Industrial Waste Discharge Ditch. The Industrial Waste Pond and the Industrial Waste Discharge Ditch will remain in service to dispose of auxiliary cooling tower waste waters, condenser water, and steam condensate.

Table 7-1. Sites retained for evaluation in the feasibility study because of human health risks.

ANL-W Release Site	Exposure Scenario	Exposure Pathway	Contributing COC	Calculated Excess Cancer Risk	Exposure Pathway Excess Cancer Risk
ANL-01-IWP	0-25-year Occupational	External Radiation Exposure	Cs-137	8E-04	9E-04
			Ra-226	1E-04	
	30-55-year Occupational	External Radiation Exposure	Cs-137	4E-04	5E-05
			Ra-226	1E-04	
	100-year Residential	External Radiation Exposure	Cs-137	1E-04	4E-04
			Ra-226	2E-04	
ANL-09-Canal	1,000-year Residential	External Radiation Exposure	Ra-226	2E-04	2E-04
	0-25-year Occupational	External Radiation Exposure	Cs-137	5E-04	5E-04
ANL-09-Mound	30-55-year Occupational	External Radiation Exposure	Cs-137	2E-04	2E-04
	0-25-year Occupational	External Radiation Exposure	Cs-137	8E-04	8E-04
	30-55-year Occupational	External Radiation Exposure	Cs-137	4E-04	4E-04
	100-year Residential	External Radiation Exposure	Cs-137	1E-04	1E-04

Table 7-2. Summary of WAG 9 sites retained for evaluation in the feasibility study because of ecological risks.

Site	Nonradionuclide		Radionuclide internal		Radionuclide external	
	Contaminant	HQ ^a	Contaminant	HQ	Contaminant	HQ
ANL-01	Aluminum	>1000 and <10000	Initially Screened		Initially Screened	
	Antimony	>1 and <10				
	Arsenic	>10 and <100				
	Barium	>10000				
	Beryllium	>1 and <10				
	Cadmium	>1000 and <10000				
	Chloride	>1 and <10				
	Chromium III	>1000 and <10000				
	Chromium VI	>100 and <1000				
	Copper	>10 and <100				
	Cyanide	>10 and <100				
	Lead	>10 and <100				
	Magnesium	>10000				
	Manganese	>10 and <100				
	Mercury	>100 and <1000				
	Nickel	>10 and <100				
	Selenium	>10 and <100				
	Silver	>10 and <100				
	Sodium	>1 and <10				
	Sulfate	>100 and <1000				
ANL-01A	Thallium	>1 and <10				
	Vanadium	>100 and <1000				
	Zinc	>100 and <1000				
	Antimony	>1 and <10	Initially Screened		Initially Screened	
	Arsenic	>10 and <100				
	Barium	>1000 and <10000				
	Chromium III	>10 and <100				
	Chromium VI	>1 and <10				
	Cobalt	>1 and <10				
	Copper	>10 and <100				
	Cyanide	>10 and <100				
	Lead	>100 and <1000				
	Manganese	>10 and <100				
	Mercury	>100 and <1000				
	Nickel	>100 and <1000				
	Selenium	>1 and <10				
	Silver	>1 and <10				
	Sodium	>1 and <10				
	Vanadium	>100 and <1000				

Site	Nonradionuclide		Radionuclide internal		Radionuclide external	
	Contaminant	HQ*	Contaminant	HQ	Contaminant	HQ
ANL-04	Zinc	>10 and <100				
	Aluminum	>1000 and <10000	Initially Screened		Initially Screened	
	Antimony	>1 and <10				
	Arsenic	>10 and <100				
	Barium	>1000 and <10000				
	Chromium III	>10 and <100				
	Copper	>100 and <1000				
	Cyanide	>100 and <1000				
	Lead	>100 and <1000				
	Magnesium	>10 and <100				
	Mercury	>100 and <1000				
	Selenium	>10 and <100				
	Silver	>10 and <100				
	Sodium	>10 and <100				
	Vanadium	>100 and <1000				
	Zinc	>100 and <1000				
ANL-05	Sodium	>10 and <100	Initially Screened		Initially Screened	
ANL-09	Arsenic	>10 and <100	Initially Screened		Initially Screened	
	Copper	>1 and <10				
	Lead	>10 and <100				
	Mercury	>10 and <100				
ANL-29	Silver	>10 and <100	None		None	
ANL-35	Aluminum	>1000 and <10000	Initially Screened		Initially Screened	
	Arsenic	>10 and <100				
	Barium	>1000 and <10000				
	Beryllium	>1 and <10				
	Cadmium	>100 and >1000				
	Chromium III	>1 and <10				
	Copper	>10 and <100				
	Cyanide	>10 and <100				
	HpCDD	>1 and <10				
	Lead	>10 and <100				
	Magnesium	>1000 and <10000				
	Manganese	>100 and <1000				
	Mercury	>10 and <100				
	Nickel	>10 and <100				

Nonradionuclide			Radionuclide internal		Radionuclide external	
Site	Contaminant	HQ ^a	Contaminant	HQ	Contaminant	HQ
	OCDD	>1 and <10				
	Selenium	>1 and <10				
	Silver	>100 and <1000				
	Sodium	>1 and <10				
	Sulfate	>1 and <10				
	Thallium	>1 and <10				
	Vanadium	>100 and <1000				
	Zinc	>10 and <100				
ANL-36	Silver	>1 and <10	None		None	
ANL-61A	None exceeded target value		None		None	

a. This represents the maximum HQs calculated across functional groups and T/E species.

While the Interceptor Canal will remain in service as a diversion approximately 14 square miles of surface area south of the ANL-W around the facility to the Industrial Waste Pond.

The OU 9-04 list of sites retained for the FS were grouped into two broad categories to facilitate identification and analysis of alternatives. The two categories were made after review of Tables 7-1 and 7-2 and are based on the contaminant and the pathway. This approach is consistent with the intent to focus and streamline the FS. Categories are retained through the identification and screening of alternatives; however, sites are addressed individually in the detailed analysis of alternatives as needed with the exception of sites with ecological concerns which are addressed all together. Categories include radiologically contaminated sites, sites with arsenic that contribute to the groundwater, and sites with ecological concerns. The distribution of specific sites into categories is shown in Table 7-3.

Table 7-3. Distribution of OU 9-04 release sites addressed in this FS.

Radiologically Contaminated Sites	Sites with Ecological Concerns
ANL-01-Industrial Waste Pond	ANL-01 (IWP, Ditch A, B, and C)
ANL-09-Canal	ANL-01A-MCTBD
ANL-09-Mound	ANL-04
	ANL-09
	ANL-35

7.2 Assumptions

The assumptions detailed in this section which are critical to the development and preparation of this FS include:

1. The OU 9-04 FS uses a format focused on the identification, screening, and analysis of alternatives, similar to that used for other INEEL WAGs.
2. A biotic barrier is required for all containment alternatives that are evaluated for sites which contribute to ecological risks.
3. RAOs for OU 9-04 are identical to those developed for other INEEL WAGs FS, with exceptions identified in Section 7.3.
4. Groundwater contamination due to infiltration of waste waters was demonstrated in the RI/FS report to potentially cause a cumulative risk to future residents for the ingestion of groundwater and inhalation of water vapors from indoor water use; is caused from the accumulation of arsenic from continuous use of groundwater since the arsenic has not been added to the effluent discharges associated with the cooling tower or the Sewage Lagoons.

5. A minimum of 100 years of institutional control would be implemented at all sites where contaminant concentrations exceeding allowable ranges are left in place. The need for institutional control would be evaluated and determined by the Agencies during 5-year reviews following site closure.

7.3 Remedial Action Objectives

RAOs for OU 9-04 are developed in accordance with NCP and CERCLA RI/FS guidance (EPA 1988a). The RAOs identified for OU 9-04 have been defined through discussions among the key agencies (IDHW, EPA, and DOE). RAOs provide the basis for developing GRAs that will satisfy the objectives of protecting human health and the environment. The RAOs specified for protecting human health are expressed both in terms of risk levels and exposure pathways because protection can be achieved through a reduction in contaminant levels, as well as through the reduction or elimination of exposure pathways. The RAOs specified for protecting the environment are intended to either preserve or restore the resource.

Development of RAOs for OU 9-04 is based on the results of the baseline risk assessment (BRA). The summary of the sites which are retained for evaluation in the FS are shown in Tables 7-1 and 7-2. RAOs are specific to each sites COCs, and potential exposure pathways for the sites of concern. The RAOs developed for OU 9-04 sites are the following:

- For protection of human health:
 - Inhibit direct exposure to radionuclide COCs that would result in a total excess cancer risk of greater than 1 in 10,000 to 1,000,000 ($1\text{E-}04$ to $1\text{E-}06$) to current and future workers and future residents.
- For protection of the environment:
 - Inhibit adverse effects to resident populations of flora and fauna, as determined by the ecological risk evaluation, from soil or air containing COCs.

7.3.1 Contaminants and Sites of Concern

This section discusses the contaminants of concern for the OU 9-04 release sites investigated in the FS. The contaminants which contribute human health risks are shown in the fourth column of Table 7-1. Of the hundreds of potential contaminants that were analyzed, only four were determined in the human health risk assessment to have excess cancer risks greater than $1\text{E-}04$. These four are Cs-137, Ra-226, PCBs, and arsenic. The PCBs are eliminated from further discussion under this FS because the PCB contaminated soil has been removed as a housekeeping activity during the summer of 1997. The details of the PCB removal and the verification sampling are presented in Appendix L. Likewise the increase of arsenic above ANL-W site specific background concentrations has been shown in Section 5.11.2.4 to be the accumulation of low levels of arsenic precipitating out of solution onto the soils in the sites that have received large volumes of effluent waters (ANL-01-Industrial Waste Pond, ANL-01-MCTBD, ANL-04-Sewage Lagoons, and ANL-53-Riser Pits). Thus, only two contaminants, Cs-137 and Ra-226 will be evaluated in this FS as contaminants that exceed the $1\text{E-}04$ risk level. The contaminant Ra-226, exceeded the $1\text{E-}04$ risk for only one release site

ANL-01-Industrial Waste Pond. While, cesium will be evaluated for the three release sites; ANL-01-Industrial Waste Pond, ANL-09-Canal, and ANL-09-Mound.

The contaminants of concern for the OU 9-04 release sites evaluated for the ecological receptors are shown in column two of Table 7-2. With the exception of three sites, all hazard quotients that are greater than 1 are exclusively for inorganic COCs. The hazard quotients range from 1 to 10,000 depending on the analyte.

7.3.2 Media of Concern

Media of concern for OU 9-04 sites consist of contaminated soils and sediments. Table 7-4 summarizes the maximum contaminated soil and sediment dimensions of the contaminated sites as determined in Section 4 (Nature and Extent of Contamination) of the RI/BRA report.

Table 7-4. Extent of contamination for WAG 9 sites.

Release Site	Site Name	Width (ft)	Length (ft)	Depth (ft)
ANL-04	Sewage Lagoons	550	125	0.5
ANL-01	Industrial Waste Pond	200	250	0.5
ANL-01	Ditch A	5	400	0.5
ANL-01	Ditch B	5	1,400	1.3
ANL-01	Ditch C	5	500	2.5
ANL-01A	Main Cooling Tower Blowdown Ditch	6	700	2
ANL-09	Interceptor Canal	30	1,425	6
ANL-09	Interceptor Canal (Mound)	20	500	4
ANL-35	Industrial Waste Lift Station Discharge Ditch	4	500	1
ANL-53	Riser Pits (4 Pits, each with)	4	4	1.25
ANL-53	Riser Pits (North Discharge)	6	10	1.25
ANL-53	Riser Pits (South Discharge)	6	10	1.25

7.3.3 Exposure Scenario and Pathways of Concern

Exposure scenarios and pathways of concern for human health are identified in column three of Table 7-1. As shown in this table only one pathway (external radiation) exceeded the 1E-04 excess cancer risk for the release sites. The external radiation exposure exceeded the 1E-04 risk levels for the radionuclides Cs-137 and Ra-226. Also, note that release site ANL-61A was cleaned up in the summer of 1997 and thus those pathways are not included.

The exposure scenario and pathways of concern for the ecological receptors is from the plant uptake of contaminants from the soil to the edible portion of the plant. Then from the plant to a small animal, and on to a larger predator. The plant uptake factors and bioaccumulation factors have not been well defined for contaminants at the INEEL, and so the defaults used in the ecological risk calculations are very conservative. A site wide ecological sampling program is currently underway for the 1997 field season to study the soil to plant uptake factors for plant types on the INEEL. Also, the study will determine the bioaccumulation factors from the plants to the receptors. These INEEL site specific plant uptake factors (PUFs) and bioaccumulation factors (BAFs) will not be available in time to better refine the OU 9-04 ecological risk assessment. But, the PAFs and BAFs will be less than those that were used in the OU 9-04 risk assessment, since the PUFs and BAFs were assumed to be 100 percent if no site specific data was available.

7.3.4 Potential Applicable or Relevant and Appropriate Requirements

OU 9-04 ARARs were developed with the concurrence of the IDHW and EPA. A preliminary list of ARARs prepared for the OU 9-04 RI/FS Work Plan (Lee, et al., 1996) was refined by including ARARs from OUs 5-05/6-01 considered appropriate for OU 9-04 sites, and by deleting ARARs determined not to be appropriate. Additional ARARs may be identified in the event that acquisition of new information changes the current understanding of the conditions at specific sites (i.e., changes in the list of contaminants of concern).

The list of preliminary ARARs was reduced by considering the specific application of each to the specific site conditions, locations, contaminants and potential actions at WAG 9. If no application or relevance was determined to exist, the rule was eliminated from further consideration. Remedial alternatives were subsequently evaluated on the basis of compliance with this final list of ARARs.

7.3.4.1 Action-Specific ARARs. Action-specific ARARs are usually technology- or activity-based requirements for actions taken at a site. Action-specific ARARs generally do not guide the development of remedial action alternatives, but they indicate how the selected remedy must be implemented.

The State of Idaho's rules for control of fugitive dust emissions are potentially applicable to most remedial alternatives likely to be used at WAG 9. The rules require that all reasonable precautions be taken to prevent the generation of fugitive dust and are located in Idaho Air Pollution Act (IDAPA) 16.01.01650 et seq.

The State of Idaho has established emission standards for any toxic substances not specifically controlled in other state air pollution control regulations (IDAPA 16.01.01161). These regulations prohibit the emission of toxic contaminants in sufficient quantities or concentrations that would, alone or in combination with other contaminants, injure or unreasonably affect humans, animals, or vegetation. These standards are considered applicable to remedial actions conducted under OU 9-04.

When RCRA requirements are ARARs, only the substantive requirements of RCRA must be met if a CERCLA action will be conducted on-site. On-site CERCLA actions do not require RCRA permits or compliance with administrative requirements (OSWER, 1989). CERCLA actions to be conducted off site, however, must comply with both substantive and administrative RCRA requirements. The determination of if RCRA is Applicable or Relevant and Appropriate depends on the hazardous properties of the waste, its

composition, and nature of the release. Typically, RCRA is Applicable if the waste is RCRA hazardous, and either: the waste was initially treated, stored, or disposed of after the effective date of the particular RCRA requirement, or the activity at the CERCLA site constitutes treatment, storage, or disposal, the as defined by RCRA. A waste has similar composition to a known, listed RCRA waste, RCRA requirements may be potentially Relevant and Appropriate depending on the circumstances at the site. Thus, for all WAG 9 CERCLA sites, the final determination whether a RCRA applicable or relevant and appropriate will be made on a case by case basis. The following is a list of potential ARARs for all WAG 9 CERCLA sites under the Idaho Hazardous Waste Management Act:

- IDAPA 16.01.05.004 and .005 (40 CFR 260.10 and 261.2) "Definition of Solid Waste"
- IDAPA 16.01.05.006 (40 CFR 262.11) "Hazardous Waste Determination"
- IDAPA 16.01.05.005 (40 CFR 261) "Identification and Listing of Hazardous Waste"
- IDAPA 16.01.05.008 (40 CFR 264) "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities"
- IDAPA 16.01.05.011 (40 CFR 268) "Land Disposal Restrictions."

The MCTBD is a RCRA LDU and will be remediated under the CERCLA process in accordance with the applicable substantive requirements of RCRA/HWMA, if an unacceptable risk to human health or the environment is demonstrated. However, the Federal Facility Agreement and Consent Order (FFA/CO) has only adopted RCRA corrective action [3004 (u) & (v)], and not RCRA/HWMA closure. Therefore, upon completion of the remedial action, the DOE-CH must receive approval from the IDHW/DEQ director that the MCTBD has been closed pursuant to RCRA/HWMA closure requirements.

7.3.4.2 Chemical-Specific ARARs. Chemical-specific ARARs are usually health- or risk-based numerical substantive requirements of the values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values for a constituent. These values establish the acceptable amounts or concentrations of a chemical that may be found in or discharged to the ambient environment.

The National Emission Standard for Hazardous Air Pollutants (NESHAP) (40 Code of Federal Regulations CFR 61.92) establishes emission limits of radionuclides other than radon from DOE facilities. The standard emission limits to ambient air from an entire facility can not exceed an amount that would cause any member of the public to receive a dose equivalent of 10 mrem/yr in excess of background. These requirements are considered potentially applicable to remedial actions initiated at WAG 9.

The State of Idaho's rule governing new sources of toxic air pollutants (TAPs), located in IDAPA 16.01.01.210, 16.01.01.585 and 16.01.01.586, is a potential requirement if a remedial option generates regulated TAPs. If TAPs emissions exceed relevant screening levels, appropriate air modeling would be performed to determine ambient air concentrations. Toxic air pollutants reasonably available control technologies (T-RACT) would be employed to control emissions if the acceptable ambient air

concentrations could be exceeded. Should remedial action be necessary under the OU 9-04 RI/FS, air screening analysis would be performed to determine the levels of emissions that are likely associated with the options being proposed. In addition, the Safe Drinking Water Act applies to ensure protection of the groundwater beneath WAG 9.

7.3.4.3 Location-Specific ARARs. A number of statutes have requirements related to activities occurring in particular locations. For instance, waste management activities in flood plains are restricted under RCRA. Location-specific ARARs are regulatory requirements or restrictions placed on activities in specific locations that must be met by a given remedial action. These location-specific ARARs are used in conjunction with chemical-specific and action-specific ARARs to ensure that remedial actions are protective of human health and the environment.

Specific characteristics of the WAG 9 area considered in this evaluation are (a) its location with respect to flood plains, (b) its location with respect to seismic regions, (c) the potential presence of endangered species, (d) the proximity of surface water, (e) the presence of archaeological and historical sites, and (f) the presence of drinking water wells.

Location-Specific ARARs Inappropriate to WAG 9. The WAG 9 area is not located in a 100-year flood plain. Based on topographic maps of the ANL-W area, approximately a 14-square miles of area south of ANL-W is drained around the south and west sides of the ANL-W facility. A drainage ditch routes water to the west side of ANL-W to the Interceptor Canal (ANL-09) which has been investigated under this comprehensive RI/FS. The water drained to the Interceptor Canal is at best an intermittent stream caused by rapidly melting snow or a major rainfall. The water drained from the Interceptor Canal ultimately discharges to the Industrial Waste Pond (ANL-01), an artificially enhanced catch basin where it evaporates and infiltrates into the ground.

The area surrounding ANL-W has been surveyed for cultural resources in the past, and no sites of archaeological or historical value were found within a mile of the facility. All potential remedial areas within the fenced area of ANL-W are considered disturbed areas that do not contain material of archaeological or historical significance. Therefore, the regulatory requirements associated with the preservation of antiquities and archaeological materials/sites will not serve as ARARs for any activities at WAG 9.

WAG 9 is not located within a critical habitat of an endangered or threatened species, including bald and golden eagles, nor are such species known to frequent the WAG 9 proximity. However, bald eagles, golden eagles, and American peregrine falcons have been observed on the INEEL. In addition, eight species of concern to the Idaho Department of Fish and Game and Federal Bureau of Land Management have been observed on the INEEL. Remedial activities at WAG 9 are not expected to affect any endangered species, because activities are anticipated to be conducted entirely in previously disturbed areas, and limited in both duration and affected area. However, before initiation of a remedial action potential impacts to endangered species may be further evaluated, if deemed necessary.

No fish or wildlife addressed by the Threatened Fish and Wildlife Act are found at WAG 9, nor do the planned activities at WAG 9 involve the modification of a stream, because no annual or perennial streams are located on the site and surface runoff is controlled. Migratory waterfowl are observed at the WAG 9 site during the spring and fall migrations. However, the area contains no critical habitat, and only one best management remedial action at this time (ANL-61A) that does not have a potential for adverse impacts to migratory waterfowl.

Location-Specific ARARs Appropriate To WAG 9. Two sites located within the WAG 9 area may be deemed as potentially eligible for the National Register of Historic Places (NHRP). The sites include the EBR-II Experimental Breeder Reactor and the Fuel Conditioning Facility. Remedial activities within WAG 9 are not expected to affect the facilities; however, should future planning identify activities that could potentially impact the facilities, proper mitigative measures would be identified through discussions with the Idaho State Historical Preservation Office. Table 7-5 summarizes ARARs identified to apply to remedial actions at OU 9-04.

Table 7-5. ARARs for remedial actions at OU 9-04.

ARAR Statute	ARAR Type	Citation	Applicable (A) or relevant and appropriate (R) requirement
Idaho Fugitive Dust Emissions	Action	IDAPA 16.01.01650 et seq.	A
Toxic Substances	Action	IDAPA 16.01.01161	A
Idaho Hazardous Waste Management Act	Action	- IDAPA 16.01.05.004 and .005 (40 CFR 260.10 and 261.2—"Definition of Solid Waste" - IDAPA 16.01.05.006 (40 CFR 262.11)— "Hazardous Waste Determination" - IDAPA 16.01.05.005 (40 CFR 261)— "Identification and Listing of Hazardous Waste" - IDAPA 16.01.05.008 (40 CFR 264)— "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities" - IDAPA 16.01.05.011 (40 CFR 268)— "Land Disposal Restrictions"	A
NESHAPS-Radionuclides other than Radon-222 and Radon-220 at DOE facilities -Emission Standard	Chemical	40 CFR 61.92	A
Rules for the Control of Air Pollution in Idaho	Chemical	IDAPA 16.01.01.210, 16.01.01.585 and 16.01.01.586	A
Safe Drinking Water Act	Chemical	40 CFR 141	R
National Historic Preservation Act	Location	16 USC 470 et seq.	A
Storm Water Discharge Requirements	Location	40 CFR 122.26	A
Idaho Hazardous Waste Management Act-Location Standards	Location	IDAPA 16.01.05.008	A
Prevention of Significant Deterioration of Air Quality	Location	IDAPA 16.01.01.581	A

7.3.5 To-Be-Considered Criteria, Advisories, or Guidance

A to-be-considered (TBC) list identifies criteria, advisories, guidance, or policies that do not meet the definition of ARARs but that may assist in determining what is protective in the absence of an ARAR for a specific contaminant or circumstance. Preliminary TECs for the WAG 9 site include:

- DOE orders. Orders that may apply are listed in Table 7-6.
- Executive orders.
- Federal and state rules pertaining to relevant subjects that are not promulgated criteria, limits or standards [by definition of Section 121(d) of CERCLA].
- EPA guidance documents.
- Remedial action decisions at similar Superfund sites.

Table 7-6 presents the list of potential TBCs for WAG 9. DOE Order 5820.2A is the primary TBC affecting OU 9-04 sites of concern. This order addresses on- and off-site management of low-level waste, and is typically applied to management of radionuclide-contaminated soils.

Table 7-6. Preliminary to-be-considered DOE guidance.

Guidance	Title
DOE Orders	
5480.4	“Environmental Protection, Safety, and Health Protection Standards”
5820.2A	“Radioactive Waste Management”
5400.1	“General Environmental Protection”
5400.5	“Radiation Protection of the Public and Environment”

7.3.6 Preliminary Remediation Goals

Preliminary remediation goals (PRGs) are quantitative cleanup levels, based primarily on ARARs and risk-specific doses (EPA 1988a). PRGs are used in remedial action planning and assessment of effectiveness of remedial alternatives. Final remediation goals are based on the results of the BRA, and evaluation of expected exposures and risks for alternatives, and consider effects of multiple contaminants. The OU 9-04 ROD will present final remediation goals.

The 1E-04 risk or HQ=1 level, whichever is more restrictive for a given contaminant, is the basis for determining PRGs for OU 9-04. Therefore PRGs for individual COCs were defined by calculating soil concentrations that would result in excess cancer risks equal to 1E-04 or a HQ=1 to hypothetical residents present at the end of the 100-year institutional control period, summed by pathway and all COCs present at

each site. A given COC may have different PRG values at different sites, because some sites have more COCs for a pathway than others. For example, if a given site only has one contaminant requiring remediation, the contaminant's PRG would equal the contaminant's risks = $1\text{E-}04$ or $\text{HQ}=1$ residential risk-based concentration. If, on the other hand, the site has two contaminants requiring remediation, the PRG for each contaminant would equal the risk= $5\text{E-}05$ or $\text{HQ}=0.5$ risk-based concentration for each contaminant, so that the total risk for the site would equal $1\text{E-}04$ ($2 \times 5\text{E-}05 = 1\text{E-}04$) or the total hazard index (HI) for the site would equal 1 ($2 \times 0.5 = 1$). This analysis method assures that each contaminant would have to be remediated to the same risk level in order to achieve an acceptable risk for the site.

External exposure to radionuclides is the primary exposure pathway of concern for OU 9-04 COCs, and soil concentrations resulting in a $1\text{E-}04$ risk due to external exposure are orders of magnitude lower than for other pathways. Results for OU 9-04 human health COCs are listed in Tables 7-1. For comparison purposes, the risk of $1\text{E-}04$ was used to determine the concentrations for each of the contaminants is shown in Table 7-7. Table 7-7 shows that the PRG of Cs-137 = 23.3 pCi/g for ANL-01-Industrial Waste Pond, ANL-09-Canal, and ANL-09-Mound. In addition, for ANL-01-Industrial Waste Pond the Ra-226 PRG is 0.61 pCi/g.

For the sites with ecological concerns, the PRGs depend on the size of the site as well as the contaminant concentration. Thus, the PRGs for similar contaminants will vary by site. Also, ANL-W will use the background concentration in the risk calculations to determine its resultant HQ by site. Then a backward calculation of the risk will then be used to determine the soil concentration that equals the background HQ times 10.

7.4 Areas and Volumes of Interest

This section defines the areas and volumes of contaminated media at OU 9-04 sites of concern. The contaminated media at OU 9-04 consist of radiologically contaminated and sites with ecological concerns. The waste volumes presented below are based on information presented in the OU 9-04 RI/FS. Estimated areas, depths, and volumes of contaminated material at OU 9-04 are summarized in Table 7-8. The depths of the contamination were determined in Section 4 (nature and extent of contamination) of this RI/FS. Color intensity maps shown for most sites in Appendix A graphically show the concentrations of contaminants in these sites. The following sections provide a brief description of the sites retained in this FS for human health risks.

Table 7-7. Human Health PRGs for soil contamination at OU 9-04.^a

Site	Contaminant	PRG
		(mg/kg or pCi/g)
ANL-01-IWP	Cs-137	23.3
	Ra-226	0.61
ANL-09-Canal	Cs-137	23.3
ANL-09-Mound	Cs-137	23.3

a. PRGs are soil concentrations of COCs that would result in a cumulative excess cancer risk of $>1\text{E-}04$, via the 100-year residential exposure scenario.

7.4.1 ANL-01-Industrial Waste Pond

The Industrial Waste Pond (IWP) is an unlined, approximately 1.2-ha (3-acre) evaporative seepage pond fed by the Interceptor Canal, Industrial Waste Ditch, and site storm drainage ditches. The pond was excavated in 1959, with a maximum water depth of about 4 m (13 ft), and is still in use today. During this time, the Cooling Tower Blowdown ditches have been rerouted several times. ANL-W auxiliary cooling tower blowdown ditches convey industrial wastewater from the EBR-II Power Plant and the Fire Station (Bldgs. 768 and 759) to the Industrial Waste Pond. The IWP was originally included with the Main Cooling Tower Blowdown Ditch (MCTBD) as a Land Disposal Unit under the RCRA Consent Order and Compliance Agreement on the basis of potentially corrosive liquid wastes discharged to these units. However, ANL-W conducted a field demonstration with the EPA and State of Idaho representatives in attendance in July 1988 that showed that any potentially corrosive wastes discharged to the IWP were neutralized in the MCTBD before reaching the IWP. On that basis, EPA removed the IWP as a Land Disposal Unit and re-designated it as a Solid Waste Management Unit. Therefore, this site is still under the regulatory authority of RCRA in addition to being on the FFA/CO and under the regulatory authority of CERCLA.

7.4.2 ANL-09-Canal

The ANL-W Interceptor Canal was utilized to transport industrial waste to the Industrial Waste Pond and to divert storm runoff waters around the ANL-W facility for flood control. Between 1962 and 1975, two 4-in. pipes transported liquid industrial wastes and cooling tower effluent, to the Interceptor Canal. One line transported cooling tower blowdown water and regeneration effluent while the other line originated at the Industrial Waste Lift Station (Bldg. 760) and transported industrial wastes. Liquid radioactive wastes were discharged through the same line as the industrial wastes, but they were diverted to the EBR-II Leach Pit. Discharge of industrial wastes was discontinued in 1973, and discharge of cooling tower blowdown water was discontinued in 1975.

For the majority of the metals that have maximum detected concentrations greater than background concentrations (i.e., arsenic, copper, lead, mercury, and silver), the maximum detected concentrations are only slightly higher (i.e., less than a factor of two) than background concentrations. For the radionuclides with maximum detected concentrations greater than background (i.e., Am-241, Co-60, Cs-134, Cs-137, Sr-90, and U-238) and that were collected at more than one depth (i.e., Am-241, Co-60, Cs-134, and Cs-137), all soil concentrations decreased with increased depth. A planer map of this area along with maps that show concentrations verses depth of arsenic, copper, lead, and mercury, Co-60 and Cs-137 are at the end of Appendix B.

7.4.3 ANL-09-Mound

The ANL-09-Mound release site was formed as an extension of the CERCLA identified release site ANL-09-Canal. The mound area consists of contaminated soil that was dredged from the bottom of the canal and stockpiled on the canal bank. During removal of the cattails and reeds from the Interceptor Canal in

Table 7-8. Areas, depths, and volumes of contaminated soil at OU 9-04 sites of concern.

Site	Surface area (ft ²)	Depth of contamination (ft)	Contaminated soil volume (ft ³)
Human Health Sites			
ANL-01-IWP	50,000	0.5	25,000
ANL-09-Canal	42,750	6	256,500
ANL-09-Mound	10,000	4	40,000
ANL-01A-MCTBD	4,200	2	8,400
Ecological Sites			
ANL-01A-MCTBD	4,200	2	8,400
ANL-01-Ditch A	2,000	0.5	1,000
ANL-01-Ditch B	7,000	1.3	9,100
ANL-01-Ditch C	2,500	2.5	6,250
ANL-04	77,500	1	77,500
ANL-35	2,000	1.0	2,000

October 1969, radiologically contaminated soil were identified above background levels. Wastewater was diverted to an adjacent parallel ditch (ANL-01 Ditch B), and radioactive liquid waste was accidentally discharged, resulting in contamination to the surface soils of ANL-01 Ditch B. Additional radiation surveys in 1969, 1973, and 1975 indicated that the entire length of the Interceptor Canal and ANL-01 Ditch B were contaminated. In 1975, approximately 3,471 m³ (4,540 yd³) of radiologically contaminated soil was identified in the Interceptor Canal and ANL-01 Ditch B. Of which, approximately 809 m³ (1,058 yd³) of contaminated soil was removed and stockpiled on the west bank of the Interceptor Canal and is now called the (ANL-09-Mound).

7.4.4 ANL-01A-MCTBD

The Main Cooling Tower Blowdown Ditch (MCTBD) runs from the Westside of the cooling tower north, between the security fence to the Industrial Waste Pond. It is an unlined channel approximately 213 m (700 ft) in length and 0.9 to 4.6 m (3 to 15 ft) wide. From 1962 to present, the ditch has been utilized to convey industrial wastewater from the Cooling Tower to the Industrial Waste Pond. The main source of impurities to the Industrial Waste Pond were water treatment chemicals associated by cooling water and those used to regenerate the ion exchange resin, which removes minerals from cooling tower water used in the EBR-II steam system. From 1962 to July 1980, a chromate-based corrosion inhibitor was added to the Cooling Tower water. The blowdown contained significant quantities of hexavalent chromium. Ion exchange column regeneration effluent was discharged directly to the ditch from 1962 to March 1986. Regeneration of these columns is accomplished with sulfuric acid for cation columns and sodium hydroxide for anion columns. The ecological risk assessment indicates that the inorganics pose potentially unacceptable risks.

7.4.5 ANL-01-Ditch A, Ditch B, and Ditch C

Currently, all three ditches (i.e., Ditches A, B, and C) discharge to the MCTBD, which then discharges to the IWP. These three ditches were used to transport both surface runoff and secondary cooling water to the IWP. Because of the physical separation of these ditches to the pond, each ditch (A, B, and C) and the IWP were screened separately. Samples have been collected from the soil, sludge, and water present in the IWP and soil samples have been collected from the ditches; these samples were analyzed for volatile and semivolatile organic compounds, metals, PCBs, pesticides, herbicides, dioxin/furans, and radionuclides. The results of the ecological risk assessment indicate that the inorganic pose potential risks to the ecological receptors.

7.4.6 ANL-04-Sewage Lagoons

The sanitary sewage lagoons are located at the Sanitary Sewage Treatment Facility, north of the ANL-W facility. Two lagoons were constructed in 1965 along with a third built later in 1974. According to engineering drawings, the three sanitary sewage lagoons cover approximately two acres. With references to ANL-W Plot Plan as shown in Figure 1-1, the lagoons approximate dimensions are: (#1)—46 × 46 × 2.1 m (150 × 150 × 7 ft), (#2)—15 × 30 × 2.1 m (50 × 100 × 7 ft), and (#3)—38 × 122 × 2.1 m (125 × 400 × 7 ft). The lagoons receive all sanitary wastes originating at ANL-W, with the exception of the Transient Reactor Test Facility and the Sodium Components Maintenance Shop. Sanitary waste discharged is from rest rooms, change facilities, drinking fountains, and the Cafeteria. The three lagoons are sealed with a 0.32–0.63 cm (0.125–0.25 in.) bottom bentonite liner and are situated approximately 183 m (600 ft) above the groundwater.

A large leak in the northeast corner of the third lagoon was detected after its construction in 1974. This leak resulted in the loss of over a million gallons of waste water through fissures that were not sealed completely by the bentonite. This was rectified by using a 30 mil hypalon liner over the northeast corner and sealing the seams. A study in 1992 (Braun, 1992) confirmed that the Sanitary Lagoons are functioning as evaporative ponds and not as percolating ponds, suggesting that the bentonite and hypalon liner has remained intact.

Between 1975 and 1981, photo processing solutions were discharged from the Fuel Assembly and Storage Building to the Sanitary Waste Lift Station, which discharges to the lagoons. The manager of Fuel Assembly and Storage Building during that period, estimates that approximately 1.32 Troy ounces of silver were discharged to the Sanitary Waste Lift Station. Furthermore, photo processing was discontinued at the Fuel Assembly and Storage Building in 1981 and subsequently, there has been no further releases to the lift station, or subsequently the sewage lagoons. With the exception of an occasional point source of low level medical radionuclides, there has been no known radioactive hazardous substances released into the Sewage Lagoons. Periodic sampling of the Sewage Lagoon and a radionuclide detector placed in the lift station (Sanitary Waste Lift Station-788) supplying the Sewage Lagoons support these conclusions. However, because no prior sludge samples were analyzed for metals and radionuclides, seven sludge samples were collected in 1994. The results from this sampling were used in a Track 1 risk evaluation in 1995 (ANL-W 1995a) which indicates that the 95% UCL for arsenic is 16.27 mg/kg and mean concentration of chromium to be 76.4 mg/kg exceed risk-based soil concentrations (i.e., 0.366 mg/kg and 24.9 mg/kg, respectively). This

assumes that all the chromium is hexavalent chromium. The ecological risk assessment shows that the inorganics pose potential threats to the ecological receptors.

7.4.7 ANL-35-Industrial Waste Discharge Ditch

The Industrial Waste Lift Station Discharge Ditch, also known as the North Ditch, is located inside the security fences. The ditch is approximately 152 m (500 ft) in length with a bottom width of 0.91–1.2 m (3–4 ft). At any one time, there is approximately 5–8 cm (2–3 in.) of water in the ditch. The ditch receives industrial waste from a variety of facilities at ANL-W. From 1959 through 1966 the North Ditch was part of a surface water runoff ditch. From 1966 to 1972 the North Ditch received industrial wastewater from the Instrument and Test Facility (Bldg. 772) and the Sodium Process Demonstration Facility (Bldg. 789). After 1972 when the Industrial Waste Lift Station (Bldg. 778A), ANL-29, was installed, the North Ditch received waste from this lift station. Currently, the North Ditch receives wastewater from industrial waste sources discussed above.

In 1988, soil was excavated from the North Ditch in an effort to relieve clogging in the ditch by cattails and weeds. Analysis of soil samples remaining in and excavated from the ditch indicate that all metals except beryllium (5.8 mg/kg) were below risk-based soil concentration (3.89×10^{-5} mg/kg). Although, it should be noted that this risk-based soil concentration is less than background concentration (3.0 mg/kg). In addition, low-concentrations of VOCs, dioxins/furans, and herbicides were detected. The excavated soil was boxed and disposed at the bulky waste landfill at the CFA in August 1993. The remaining soil was sampled in 1994 and the inorganics pose an unacceptable risk to the ecological receptors.

7.5 General Response Actions

GRAs identify broad categories of remedial actions that will satisfy RAOs for the environmental media associated with the OU 9-04 sites. In order to protect human health and the environment, the intent of GRAs is to eliminate source-to-receptor pathways by preventing the exposure of a receptor to the contaminant and by reducing or eliminating contaminant migration to clean media. Soil is the only medium of concern potentially targeted for remediation at the OU 9-04 sites.

GRAs, individually or in combination with other GRAs, can satisfy RAOs in one of two ways. Contaminants can be destroyed or reduced in concentration to levels posing insignificant risks to human health and the environment, or contaminants can be isolated from potential exposure and migration pathways to decrease risks to human health and the environment. Contaminant destruction is the preferred method because it ensures that RAOs have been satisfied. However, radionuclide contamination within the OU 9-04 sites cannot be destroyed and must therefore be isolated from potential exposure and migration pathways.

A range of GRAs and combinations of GRAs that could achieve varying degrees of protectiveness of human health and the environment and compliance with RAOs are defined. Six GRAs and combinations of GRAs identified for contaminated soil at OU 9-04 sites include:

- No action

- Institutional controls
- Containment and institutional controls
- Treatment in situ
- Removal, treatment ex situ, and disposal
- Removal and disposal.

The six GRAs and combinations of GRAs listed above are consistent with the objective of this focused FS, which is to use past experience from cleanup actions at other sites with similar characteristics (i.e., types of contaminants present and affected environmental media) to accelerate selection of remedial action alternatives. The OU 5-05/6-01 FS did not define in situ treatment or removal and ex situ treatment GRAs, based on prior INEEL testing and on the NCP stated expectation that non-liquid, low-level contamination be addressed by containment rather than treatment. However, GRAs incorporating treatment and treatment technology types and process options are defined and screened in this FS in order to produce a defensible report that meets NCP requirements. A brief description of each GRA identified for the OU 9-04 sites is presented below.

7.5.1 No Action

The no action GRA does not involve active remedial actions with the exception of environmental monitoring. Monitoring is included to enable identification of potential contaminant migration or other changes in site conditions that may warrant future remedial actions. Types of environmental monitoring considered for use at the OU 9-04 sites are defined in the description of alternatives presented in Chapter 9. Monitoring is an institutional control action that can be assumed to remain in effect for at least 100 years (refer to Section 7.5.2).

7.5.2 Institutional Controls

Institutional controls refer to actions taken by the responsible authorities to minimize potential danger to human health and the environment. Institutional controls are ongoing actions that can be maintained only as long as the responsible authority is in control of the site. Based on DOE Order 5820.2A, Radioactive Waste Management, active institutional control of low-level radioactive waste disposal sites is required for a minimum of at least 100 years following closure. In order to remain consistent with the BRA, the 100-year institutional control period is assumed to begin in 1997.

For the No Action alternative, in addition to the access restrictions mentioned above, long-term environmental monitoring will be implemented annually for the first 5 years after the ROD. The need for further environmental monitoring would be evaluated and determined by the Agencies during subsequent 5-year reviews.

For the containment alternative the institutional controls mentioned above will be applicable along with the maintenance of surface water diversion as necessary where contamination remains in place to ensure the

functionality of the containment systems. Samples will be collected annually for the first 5 years following completion of the cap. The need for further environmental monitoring would be evaluated and determined by the Agencies during subsequent 5-year reviews.

7.5.3 Containment and Institutional Controls

This GRA utilizes a combination of containment actions and institutional controls. Containment refers to remedial actions taken to isolate contamination from the accessible environment. Institutional controls are described in Section 7.5.2 above. Through isolation of contaminants, potential exposure pathways to human or environmental receptors are eliminated.

7.5.4 Treatment In Situ

This GRA consists of implementing technologies capable of immobilizing or reducing the toxicity or volume of contaminants in situ. No method exists for destroying radionuclide contaminants or reducing their toxicity. However, volumes of contaminated media may be reduced, and some toxic metals may be rendered less toxic through treatment. This focused FS relies on previous actions at similar sites to identify treatment technologies potentially effective at OU 9-04.

7.5.5 Removal and Treatment Ex Situ

This GRA consists of excavating contaminated soils and debris and treating them to reduce the toxicity, mobility and/or volume of the contamination. As for in situ treatment, no method exists for destroying radionuclide contaminants or reducing their toxicity. However, volumes of contaminated media may be reduced, and some toxic metals may be rendered less toxic through treatment. This focused FS relies on previous actions at similar sites to identify and screen treatment technologies potentially effective at OU 2-13.

7.5.6 Removal and Disposal

This GRA involves complete removal of material contaminated at concentrations greater than PRGs from the sites, followed by disposal at an appropriate location.

7.6 Identification and Screening of Technologies

This section discusses the methods used to identify remedial technologies and process options representative of the GRAs described previously. This FS uses a focused approach for this step of the process, relying on treatment process options demonstrated at similar sites, and/or on results of INEEL treatability studies, to identify and screen treatment process options potentially effective at OU 9-04. The focused FS approach used for OU 9-04 is similar to that used for OUs 5-05/6-01 (LMITCO 1995a). Similar sites were identified by reviewing past RODs for sites containing surficial and buried radionuclide contamination (EPA 1992). This OU 9-04 FS Report incorporates the focused FS approach to the extent that technologies and response actions demonstrated to be effective for sites with similar contaminants and contaminated media types, and in particular those demonstrated at the INEEL, are used to define applicable process options and technology types. Innovative and emerging technologies that have been demonstrated at

pilot scale are considered. This focused FS approach facilitates the selection of appropriate remedial actions by eliminating the high cost and long schedule involved with evaluating all technologies that may potentially apply.

Figure 7-1 shows the identification and screening process for remedial technologies at OU 9-04. Remedial technology types and process options were identified and screened based on effectiveness, implementability, and cost, relative to other processes within the same technology type. These are the screening criteria identified in the guidance for *Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, 1989. Each of these screening criteria will be evaluated at OU 9-04 in accordance with the definitions stated below. The detailed evaluation of the screening criteria for each of the alternatives is found in Sections 7.6.1 through 7.6.7.

Evaluation of effectiveness includes consideration of the ability of the technology to handle the two different waste types at ANL-W (radiological and ecological). The waste types and volumes of contaminated media present, and to meet RAOs; the potential impacts to human health and the environment during implementation; and proven reliability of the technology with respect to the contaminants and conditions present at the site.

Consideration of implementability includes both technical and administrative feasibility of the technology. Technical implementability includes consideration of technology-specific parameters that constrain effective construction and operation of the technology, with respect to site-specific conditions. Administrative implementability includes consideration of the ability to obtain required permits for off-site actions; availability of treatment, storage, and disposal services; and the availability of equipment and personnel required to implement the technology.

Consideration of cost includes relative estimates of capital and O&M costs. Engineering judgement is used to estimate costs as high, moderate, or low, relative to other process options in the same technology type.

7.6.1 No Action

7.6.1.1 Environmental Monitoring. Monitoring would consist of air, soil, and groundwater monitoring. Groundwater monitoring is currently implemented on a semi-annual basis in accordance with the ANL-W WAG 9 groundwater monitoring plan. Remote air monitoring equipment has been purchased for the ANL-W site. These detectors are installed and will detect ambient gamma radiation emissions and will determine if fugitive radionuclides escape release sites where contaminated soil and debris are left in place. Soil monitoring might include radiation surveys over and around sites where contaminated soil and debris are left in place to determine if radionuclides or toxic metals have been mobilized to the surface.

All of these technologies are technically and administratively implementable. Monitoring alone would not meet RAOs for the two soil categories, but may in combination with other GRAs and technologies. Costs of soil and air monitoring are relatively low, while groundwater monitoring costs are moderate. All monitoring technologies shown in Figure 7-1 pass initial screening.

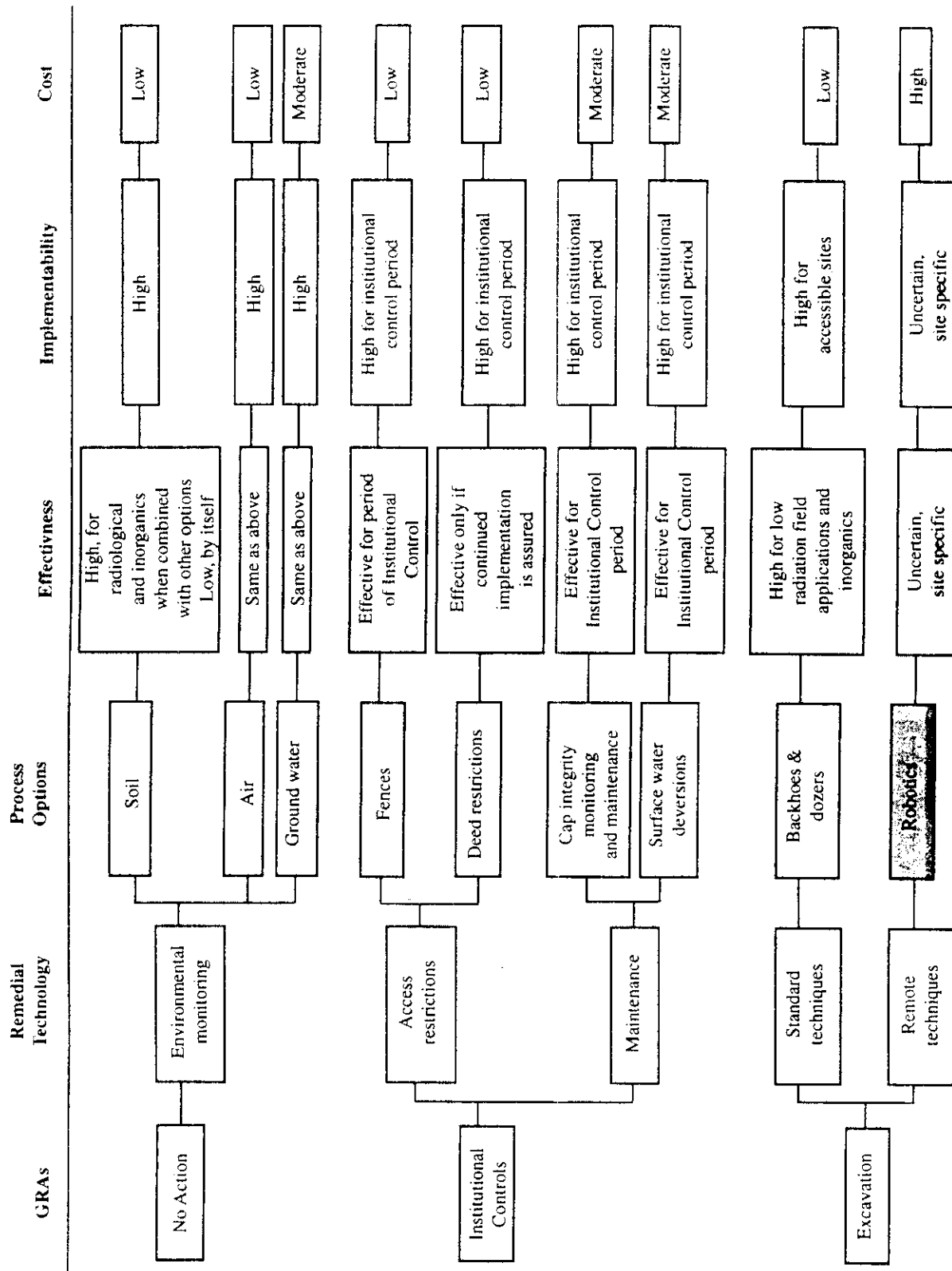


Figure 7-1. Identification and screening of remedial process options for OU 9-04 sites. Shading indicates option is screened from further consideration

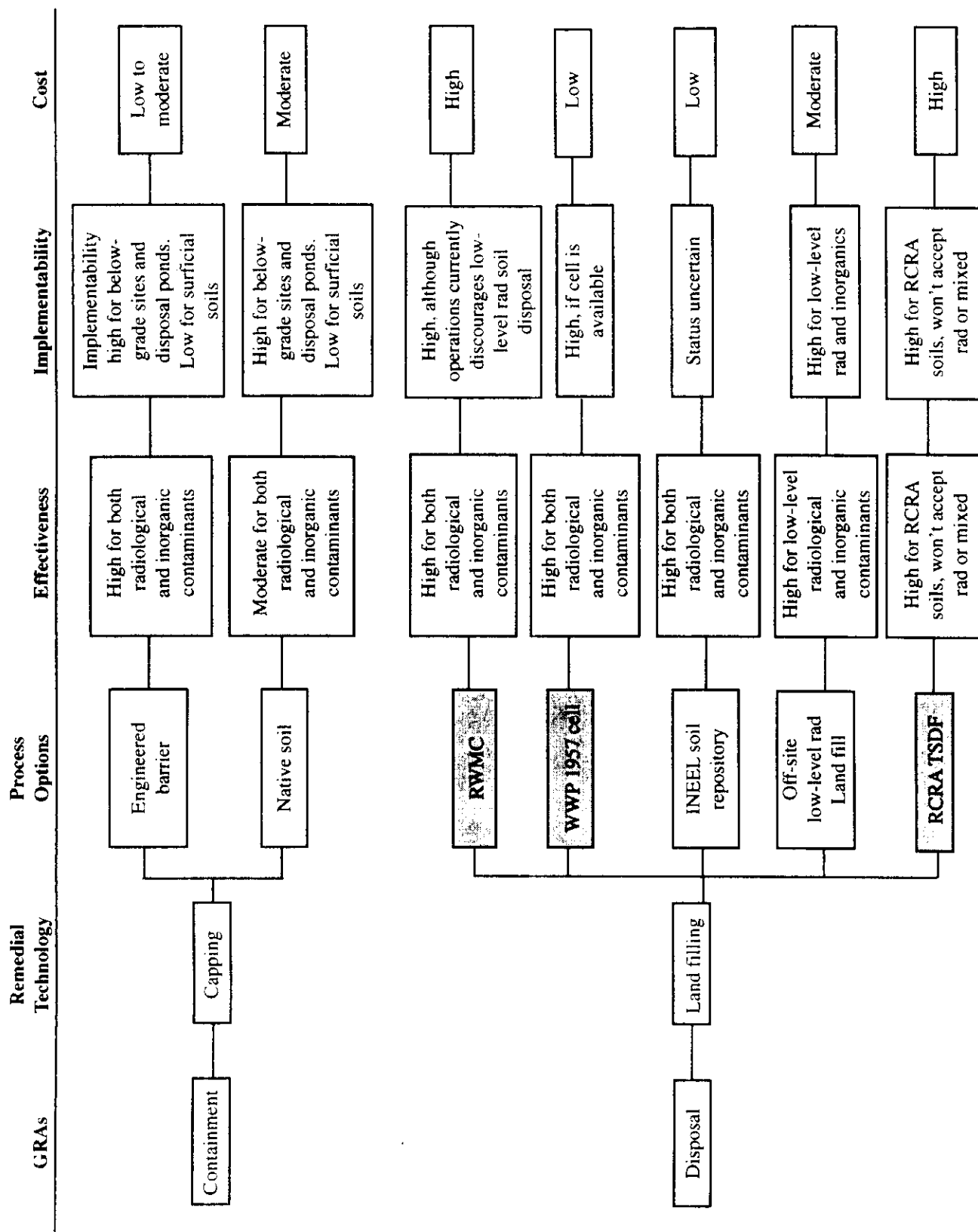


Figure 7-1. (continued).

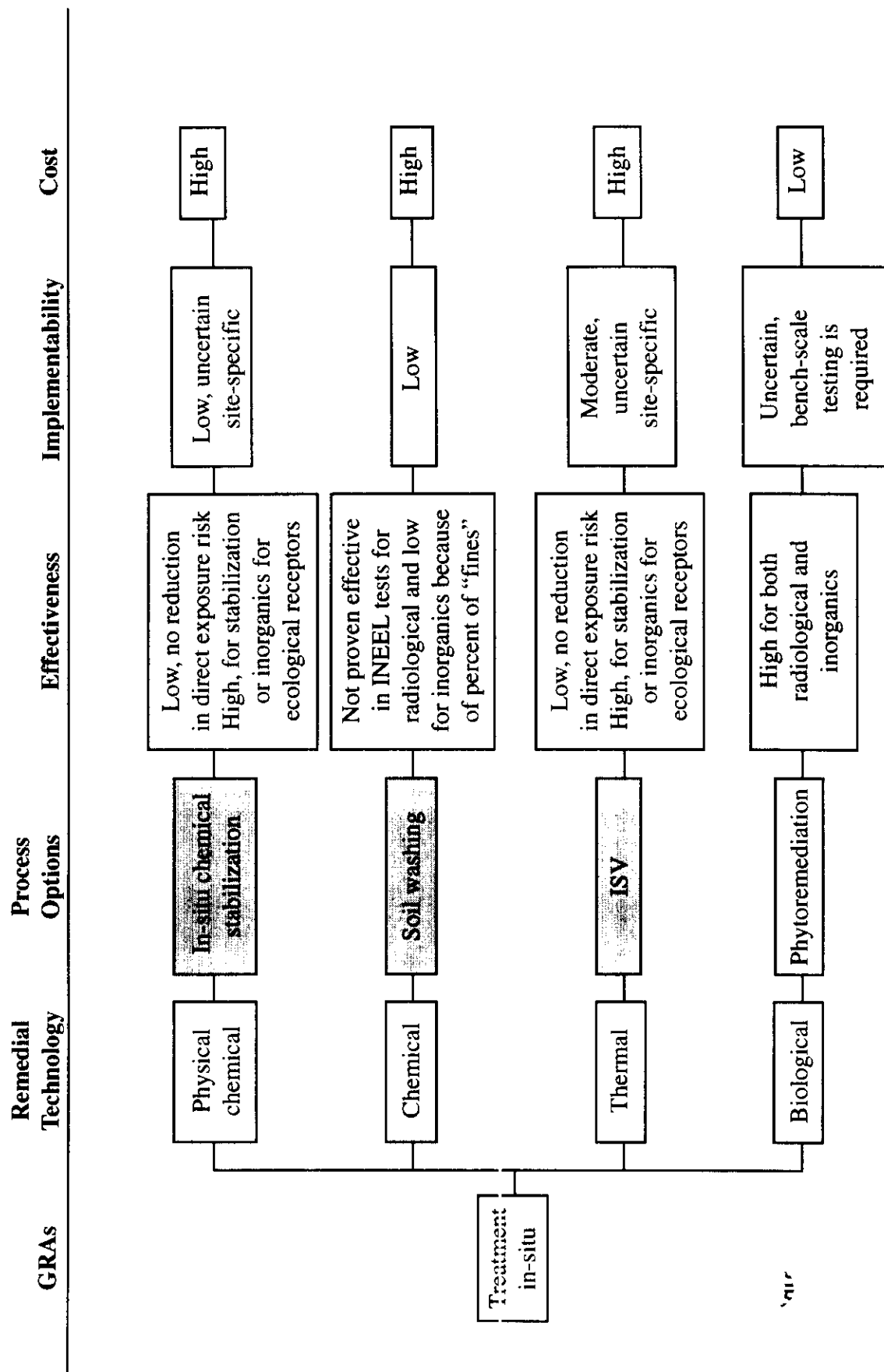


Figure 7-1. (continued).

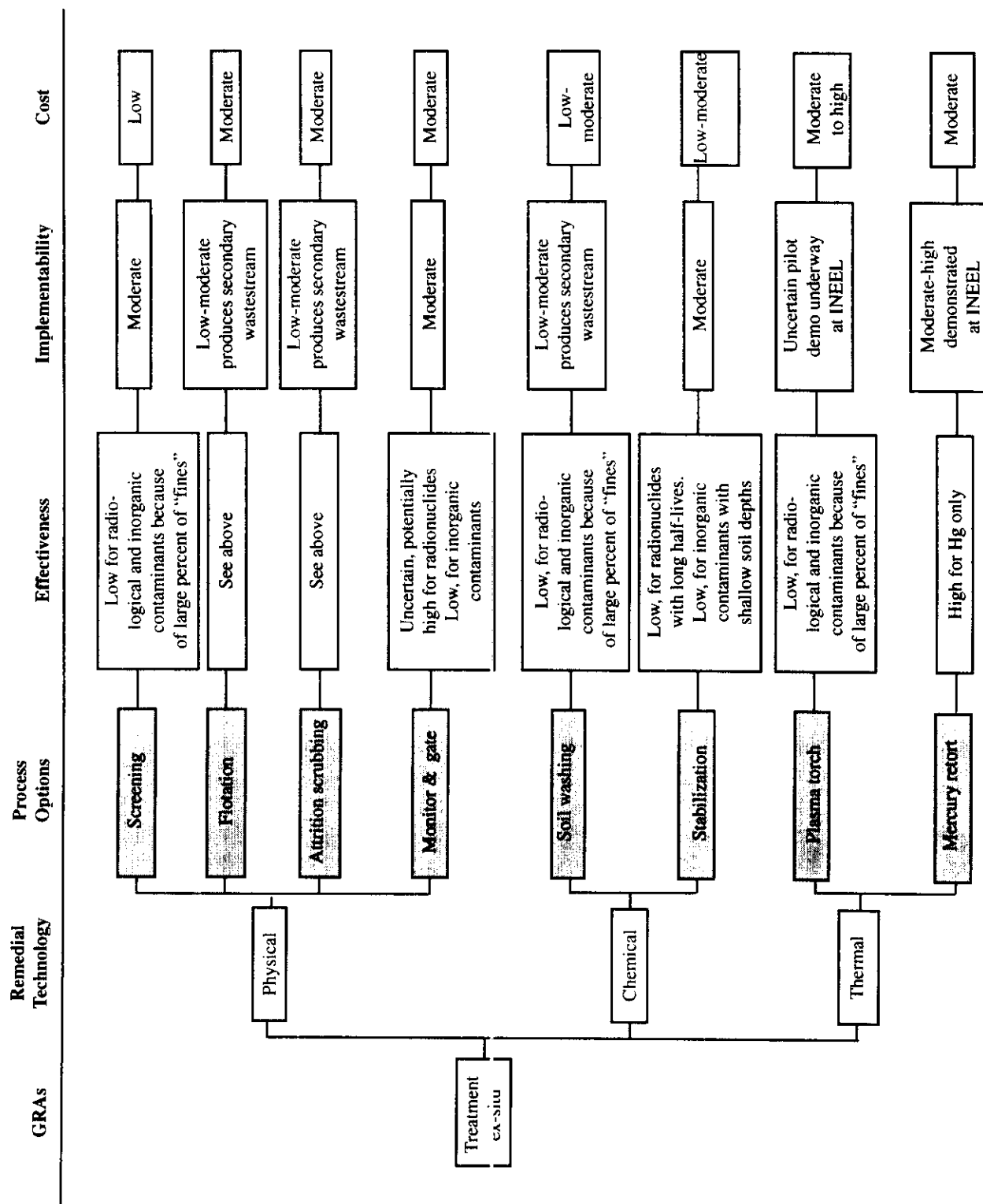


Figure 7-1. (continued)

7.6.2 Institutional Controls

Institutional controls alone would not meet RAOs for either of the two soil categories, but may in combination with other GRAs and technologies. Representative types of institutional controls are described below.

7.6.2.1 Fences. Access restrictions including fences are assumed to be maintained for at least the 100-year institutional control period following site closure. Fences must be accompanied by warning signs to be effective in controlling exposures to inadvertent intruders. Fences are completely implementable technically and administratively. Costs are relatively low.

7.6.2.2 Deed Restrictions. Deed restrictions are considered effective and implementable only for the period of institutional control. Costs are relatively low.

7.6.2.3 Cap Integrity Monitoring and Maintenance. Cap integrity monitoring and maintenance would be performed for at least the 100 year period of institutional control, to assess the physical condition of the cap and to determine if corrective actions are required. Monitoring would include visual inspections in combination with the radiation surveys described previously under environmental monitoring to determine if animal burrows, erosion or other processes had damaged the cap to a degree requiring maintenance. Maintenance would consist of filling burrows, repairing erosion damage and subsidence areas, and potentially other activities.

Cap integrity monitoring and maintenance would be effective and implementable for the institutional control period. Costs are estimated to be moderate.

7.6.2.4 Surface Water Diversions. Surface water diversions would most likely consist of maintaining existing drainage ditches and channels by regular inspection and removal of debris. No new construction would be expected to be required, except as part of design of other remedial alternatives as explained in subsequent sections. Maintaining surface water diversions would be effective and implementable for the institutional control period. Costs are estimated to be moderate.

7.6.3 Excavation

7.6.3.1 Backhoes and Dozers. These process options represent standard excavation techniques utilizing conventional equipment. Conventional construction equipment has been demonstrated to be completely effective for removing contaminated soil at depths to 20 ft bsl at the INEEL. Based on the sampling results, the contaminated soil at ANL-W is not anticipated to exceed over six feet in depth. Equipment operators can be shielded in positive pressure cabs if needed to reduce exposures during excavation. Impacts to human health and the environment could be minimized to allowable levels through administrative and engineering controls. These process options are therefore considered completely technically and administratively feasible. Costs are considered relatively low.

7.6.3.2 Robotics. This process option represents non-standard excavation techniques using remotely-operated equipment. These technologies are not globally demonstrated to be effective and implementable, and would have to be evaluated on a site-specific basis. These technologies would not significantly reduce

worker exposures, based on previous INEEL experience in contaminated site excavation. Costs are considered relatively high. This technology was therefore screened from further consideration.

7.6.4 Containment

7.6.4.1 Engineered Barrier. This technology is estimated to be highly effective in protecting human health and the environment and meeting RAOs for OU 9-04. A representative barrier type is the SL-1 cap, which consists of layers of basalt cobbles underlain and overlain by gravel, with a rock armor surface. This cap was designed to control surface exposures and inhibit biotic intrusion for the duration of risks at the site, approximately 400 years. At ANL-W the cesium-137 will be below $1\text{E-}4$ levels in 130 years, while, the inorganics will remain indefinitely. This cap has been built on the INEEL and is therefore considered highly technical and administratively implementable. Impacts to human health and the environment could be minimized to allowable levels through administrative and engineering controls. The cost of this cap is low to moderate.

7.6.4.2 Native soil cover. This cover type consists of approximately 10 ft of native INEEL soil compacted in lifts and covered with vegetation, gravel rip-rap or other media. This design is completely effective in controlling surface exposures but may not be as effective in inhibiting biointrusion as the engineered cover. Soil covers are readily implementable. Impacts to human health and the environment could be minimized to allowable levels through administrative and engineering controls. The cost of this cap is considered moderate.

7.6.5 Disposal

7.6.5.1 RWMC. Disposal of soils at the RWMC is determined to be completely effective in protecting human health and the environment and in meeting RAOs. This option has been used for prior INEEL CERCLA actions and is therefore considered readily technically and administratively feasible. Impacts to human health and the environment could be minimized to allowable levels through administrative and engineering controls. Currently, RWMC operations discourage disposal of low-level radioactively contaminated soils. However, there is no stated INEEL policy preventing the practice, so the option is retained. Costs are relatively high.

7.6.5.2 WWP 1957 cell. Disposal at the WWP 1957 cell is regarded as effective in protecting human health and the environment and in meeting RAOs, if the pond is closed so as to meet these objectives. This option has also been used for prior INEEL CERCLA Removal Actions and Interim Actions and is therefore considered technically and administratively feasible for disposal of relatively small volumes of low-level radioactively contaminated soil. All soils used to fill the WWP to grade will have to be consistent with what has been placed to date in the 1957 cell in terms of contaminant type and concentration. Impacts to human health and the environment could likely be minimized to allowable levels through administrative and engineering controls. Remaining disposal capacity is approximately $1\text{E}+04$ yd³. However, the feasibility of using this cell would depend on the remedial alternative selected for the WWP. Costs are estimated as relatively low.

This disposal option is retained for further consideration.

7.6.5.3 Future INEEL Radioactive Soil Landfill. Currently, a repository for INEEL low-level radioactively contaminated soil is being considered, to reduce the overall footprint of soil contamination at the INEEL. However, the status of this facility is uncertain. This facility is currently projected to be located south of the ICPP, and would accept INEEL CERCLA and ER radioactively- contaminated soil and debris. This facility is projected to become operational by the end of FY 1999 and operation would likely be privatized. The projected facility is currently pending public comment.

The effectiveness, implementability, and use of this facility for soils from ANL-W is still uncertain. If built, the disposal costs for this facility would likely be much lower than those for the RWMC or private low-level radioactively contaminated soil and debris landfills.

7.6.5.4 Independant low-level Radioactively-contaminated Soil Landfill. This option is considered highly effective in protecting human health and the environment and in meeting RAOs. A facility of this type exists approximately 300 miles from the INEEL, and has been previously used for disposal of INEEL radioactively- contaminated soils. Impacts to human health and the environment could likely be minimized to allowable levels through administrative and engineering controls. The wastes that this soil landfill will be able to accept will depend on the RCRA subtitle classification (i.e., C or D). Mixed wastes may be acceptable for the soil landfill depending on prior treatment and subtitle classification. This process option is therefore considered technically and administratively implementable. Costs for this option are estimated as relatively high.

7.6.5.5 RCRA TSDF. This option is considered highly effective in protecting human health and the environment and in meeting RAOs. A facility of this type exists approximately 300 miles from the INEEL and has been previously used for disposal of INEEL RCRA-contaminated soils. Impacts to human health and the environment could likely be minimized to allowable levels through administrative and engineering controls. This process option is therefore considered technically and administratively implementable. This type of facility is not warranted for wastes at ANL-W. Costs for this option are estimated as relatively high.

7.6.6 Treatment In Situ

In situ treatment options are implemented without significant excavation of contaminated media. Construction requirements may include drilling wells, digging trenches, constructing above-ground process equipment, and other activities. In situ treatment options potentially applicable to OU 9-04 sites of concern are discussed below.

7.6.6.1 In Situ Chemical Stabilization Using Mechanical Mixing. This option consists of using large-diameter augers to mix soils in situ at depths to 40 ft bls with chemical stabilization amendments to produce a stable, leaching-resistant wasteform. The effectiveness of this option in reducing risks to human health and the environment and in meeting RAOs is estimated as low. This option would not significantly reduce risks to human health via direct exposure; however, it may potentially reduce risks due to homegrown produce ingestion and soil ingestion at OU 9-04 sites. Environmental risks would be reduced or eliminated by eliminating exposure pathways. Toxicity of the radionuclides would not be reduced. Reducing mobility via leaching and infiltration to groundwater, which is a primary benefit of chemical stabilization, may reduce the inorganic risks at some OU 9-04 sites. Volume of contaminated materials would be reduced somewhat.

Impacts to human health and the environment could be minimized to allowable levels through administrative and engineering controls.

Implementability of this option is uncertain. In situ stabilization is not technically implementable for surficial soil contamination and/or drainage ditch and disposal pond sediments. In situ stabilization has been tested at the INEEL for the cold (non-waste) pit south of WAG 7. Costs are considered relatively high. This option is screened from further consideration due to low effectiveness in reducing human health risk, uncertain implementability for the drainage ditches with shallow soils to basalt, and high cost.

7.6.6.2 In Situ Soil Washing. This process uses infiltration galleries or injection wells to advect extraction fluids through contaminated soils in situ. Downgradient wells recover the fluids for separation of the contaminants and reuse. The effectiveness of this option in reducing risks to human health and the environment and in meeting RAOs is estimated as moderate. This option would reduce and potentially eliminate risks to human health and the environment from OU 9-04 sites by chemically removing contaminants for disposal elsewhere. Toxicity of the radionuclides would not be reduced. Reducing mobility via leaching and infiltration to groundwater, which is a primary benefit of chemical stabilization, would reduce risks at OU 9-04. Volume of inorganic contaminated materials would be significantly reduced.

As for ex situ soil washing, the technical implementability of this option is considered low for soils at ANL-W. Soil washing techniques were developed by the mining industry to separate metals from ores. These soil washing techniques are applicable for separating soils in which the inorganics are bonded to the fines in the soil and the fine grains (150 mesh) are less than 30 percent of the soils. At ANL-W the fines (pass 150 mesh) range from 76 to 96 percent from the ten samples of the loess soils. Copies of the grain size distributions for the ANL-W soils is shown at the end of Appendix K. Thus, the soil washing would not be economically feasible for ANL-W soils. Soil washing, in combination with physical separation, has previously been tested at bench-scale on TRA WWP sediments with poor results (INEL 1991b). In situ soil washing adds complexity due to the requirement for hydraulic control over the extractant fluid and difficulties in uniformly contacting the extractant fluid with contaminated media. Costs are considered extremely high relative to other in situ treatment technologies. Impact: to human health and the environment would be minimal.

This option is screened from further consideration due to technical applicability and low effectiveness. The soils at ANL-W contain high distribution (76-96%) of fine (<150 mesh) material and not cost effective in reducing the volume of the soil to be remediated.

7.6.6.3 In Situ Vitrification. In situ vitrification can potentially vitrify contaminated soils to create a stable, glass-like mass. Graphite electrodes are placed vertically in soil and large electrical currents applied. The soil mass bounded by the electrodes is heated to over 2000°F and melted. After cooling, the resulting wasteform is a leach resistant glass-like form similar to obsidian.

The effectiveness of this option in reducing risks to human health and the environment and in meeting RAOs is estimated as low. This option would not significantly reduce risks to human health via direct exposure; however, it would likely reduce or eliminate risks due to homegrown produce ingestion and soil ingestion at OU 9-04 sites. Environmental risks would be reduced or eliminated by eliminating exposure pathways. Toxicity of the radionuclides would not be reduced. Reducing mobility via leaching and

infiltration to groundwater, which is a primary benefit of vitrification, would reduce risks at OU 9-04. Volume of contaminated materials would not be significantly reduced. Impacts to human health and the environment could likely be minimized to allowable levels through administrative and engineering controls.

Implementability of this option is moderate to uncertain. ISV is not technically implementable for drainage ditch surficial soil contamination and/or disposal pond sediments, because of the shape of the ditches (relatively long narrow ditches with shallow soil depths). Costs are considered relatively high. This option is screened from further consideration due to low effectiveness in reducing human health risk, uncertain implementability, and high cost.

7.6.6.4 *In Situ Biological Treatment.* Phytoremediation is an innovative/emerging technology that utilizes surface vegetation to uptake toxic metals and radionuclides through roots and to degrade organic compounds in situ. Vegetation types may include grasses, shrubs, and/or trees. Metals and the radionuclides incorporated in biomass may be recovered by harvesting the vegetation and incinerating the biomass. Incinerator residuals would require disposal in a low-level radioactive waste, RCRA, or mixed-waste landfill.

Effectiveness and technical implementability of this technology are both very site-specific. Effectiveness of this technology for OU 9-04 sites of concern is uncertain. Arthur (1982) observed radionuclide uptake in INEEL vegetation including Russian thistle, crested wheatgrass, and gray rabbitbrush growing on waste disposal sites; however, this technology has not been demonstrated at the INEEL for remediation of radionuclide-contaminated soils. Immobile precipitated contaminant species are likely not recoverable by this method. Technical implementability of this technology is also uncertain for the soils at ANL-W. If non-arid climate vegetation species were used, supplemental irrigation would likely be required, which could potentially flush mobile contaminants to depths greater than those capable of recovery. Sample results of the ANL-W sites show the contaminants are predominantly bonded to the upper foot of soils. Costs of this technology are typically one-tenth of those for containment alternatives. Impacts to human health and the environment would be minimal since the plants would be harvested by typical farm machinery prior to the plants going to seed.

This option is retained for further consideration of a bench scale testing of the technologies effectiveness on ANL-W soils. The technology is implementable and costs are an order of magnitude less than other containment alternatives.

7.6.7 Treatment Ex Situ

Ex situ treatment options can be performed on excavated contaminated media. Several treatment options for INEEL soils and sediments, including physical, chemical, and thermal technologies, have been investigated at bench, and, in some cases, pilot scale. The objectives of treatment at CERCLA sites are primarily to reduce the toxicity, mobility, and/or volume of contaminated media. Toxicity of radionuclides is only reduced by natural radioactive decay. Mobility of contaminants is a primary concern at OU 9-04 sites, and may pose adverse impacts to the groundwater for the future residents and ecological receptors by plant uptake.

Effectiveness of many soil treatment options is very site-specific and depends on soil textural classification, mineralogy, chemistry, and many other factors. Evaluations of effectiveness of treatment options in this FS therefore focus on those technologies that have been demonstrated to potentially reduce INEEL and/or TRA contaminated soil and/or sediment volumes.

Construction requirements may include excavating and transporting contaminated media, constructing above ground process equipment, and other activities. Ex situ treatment options potentially applicable to OU 9-04 sites of concern are discussed below.

7.6.7.1 Physical Separation Using Screening. This technology takes advantage of the typical tendency of radionuclides to be distributed more with soil fines (silts and clays) than with coarse components (coarse sands, gravels, and cobbles). Excavated, contaminated soils can be passed through progressively finer screen sizes, using grizzly shakers or other standard process equipment, to separate fine-grained from coarse-grained fractions. This technology may be used alone or in combination with other treatment technologies to reduce the volume of contaminated soils for disposal.

This technology was tested in treatability studies using TRA WWP sediments and soils (INEL 1995). Tests determined that this process is effective at separating fine-grained from coarse-grained fractions. However, the effectiveness of screening in reducing the volume of contaminated soils is likely to be limited because Cs-137 in WWP sediments and soils is apparently not sufficiently concentrated in the fine-grained fraction to result in separation of a soil fraction that could be returned to the site, (i.e., for which Cs-137 concentrations were less than 16.7 pCi/g). About 30% of the total cesium present was in >8 mesh material (gravel and cobbles), which represented at least 60% by weight of the WWP sample sediments. The soils at the ANL-W facility are shown to have 76 to 96% of soils passing through a 150 mesh screen and the physical separation will not result in a reduced volume of the soil.

Impacts to human health and the environment during operations could be reduced to allowable levels through administrative and engineering controls. This option is technically implementable using standard process equipment. Costs are relatively low. This technology is screened from further consideration on the basis of low effectiveness for soils at ANL-W.

7.6.7.2 Physical Separation Using Flotation. Flotation separates fine-grained from coarse-grained soils by increasing their differences in settling velocities in a water clarifier. The soils would be added to a conical tank filled with water, and air introduced into the tank through diffusers or impellers. The bubbles attach to the particulates, and the buoyant forces on the combined particle and air bubbles are sufficient to cause fine-grained particles to rise to the surface where they can be recovered by skimmers. Coarse-grained materials are removed from the bottom of the tank.

This technology was tested in treatability studies using TRA WWP sediments and soils. Tests determined that this process is effective at separating fine-grained from coarse-grained fractions. However, the effectiveness of flotation in reducing the volume of contaminated soils is likely to be limited, again because Cs-137 distribution in WWP sediments and soils apparently is not sufficiently concentrated in the fine-grained fraction to result in separation of a soil fraction that could be returned to the site, i.e., for which Cs-137 concentrations were less than 16.7 pCi/g. This technology may also produce a secondary liquid wastestream.

Impacts to human health and the environment during operations could be reduced to allowable levels through administrative and engineering controls. This option is technically implementable using standard process equipment. Costs are relatively moderate. This technology is screened from further consideration on the basis of low effectiveness for the fine grained soils at ANL-W.

7.6.7.3 Physical Separation Using Attrition Scrubbing. Attrition scrubbing consists of mechanical agitation of soil and water mixtures in a mixing tank, to remove contaminants bound to particle external surfaces. This technology was not determined to be effective for cesium removal from WWP sediments and soils (INEL 1995), because only 18% of the cesium was determined to be associated with phases in and on the sediment particle coatings. The remaining 82% was determined to be associated with the particle internal mineral lattice structure and could be removed only by dissolution of the particle. However, this technology, combined with screening, was estimated to be potentially effective for soils with initial activities within 10 times the allowable level, i.e., 167 pCi/g. Further treatability studies on more representative samples from contaminated soil sites would be required to determine the effectiveness of this technology, alone or in combination with others, to reduce the volume of contaminated soils.

Impacts to human health and the environment during operations could likely be reduced to allowable levels through administrative and engineering controls. This technology also produces a secondary liquid waste stream. The effectiveness of attrition scrubbing for reducing the volume of contaminated materials at OU 9-04 sites is low to uncertain, and is therefore screened from further consideration. Costs are estimated as relatively moderate.

7.6.7.4 Physical Separation Using Gamma Monitors and Conveyor and Gate System. This technology combines a feed hopper, conveyor belt, gamma spectroscopy and a gate to separate soils moving on the belt on the basis of activity. This technology is currently under evaluation at the INEEL Pit 9 removal and treatment project to reduce the volume of excavated material requiring treatment prior to final disposal. Materials above and below allowable contaminant levels are diverted to different outlets. Soils with contaminant concentrations below allowable levels could be returned to the excavation, while soils with contaminant concentrations above allowable levels could be treated further or directly disposed of at an appropriate landfill.

The effectiveness of this technology for OU 9-04 soils and sediments is uncertain. This technology has been successfully demonstrated to reduce volumes of radionuclide-contaminated soils at several sites, and is currently being tested for the INEEL Pit 9 project. However, this technology has not been tested at the INEEL for separation of contaminated soils at the 16.7 pCi/g Cs-137 level.

This technology does not produce any secondary waste streams, and mainly utilizes conventional material-handling equipment. Gamma radiation detectors may be either germanium or sodium iodide. The gamma monitoring-conveyor-gate system may be combined with other technologies in a treatment train, for example vitrification, to stabilize the soils and sediments containing the highest activities. This option is most applicable to sites where soils have not been disturbed after contamination, i.e., are not homogenized with respect to contamination. These types of sites may include those with wind- and water-deposited contamination. This technology is likely less effective for sites where contaminated soils have been previously consolidated, for example OU 10-06 soils consolidated in the WWP 1952 and 1957 cells and

dredged soils from the Interceptor Canal. Previous uses at Savannah River and at Johnson Atoll claimed high volume reductions, however effectiveness is dependent on soil type and homogeneity of the soils. Additionally, some of the reported volume reduction was apparently due to size separation prior to processing through the scanning gate.

Impacts to human health and the environment during operations could be reduced to allowable levels through administrative and engineering controls. This technology is considered moderately implementable for WAG 9 soils due mainly to the sorting of the soils. Costs are also estimated as moderate. This technology is screened from further consideration because it is more applicable to soils that are not homogenized. The majority of the radiologically contaminated soils at ANL-W have been dredged and are homogenized (water deposited).

7.6.7.5 Soil washing. This option would consist of chemically extracting contaminants from excavated soils and debris to produce clean soils and concentrated residuals. Clean soils would likely be returned to the site of concern, and concentrated residuals would likely be landfilled. Concentrated acids are the most likely extractants.

Soil washing using concentrated nitric acid, in combination with physical separation, has previously been tested at bench-scale on TRA WWP sediments with poor results. Although cesium removal efficiency for WWP sediments for the greater than 8 mesh fraction (gravels and cobbles) exceeded 90%, cesium activity in the treated solids still exceeded the 690-pCi/g treatment goal (INEL 1991a; WINCO 1994; INEL 1995). Because of the large percentage (76 to 96%) of fines (<150 mesh) in the soils at ANL-W, little or no volume reduction of Cs-137 contaminated materials would be achieved using this method for ANL-W sediments. This technology also has the potential to generate new waste (corrosives) streams.

Toxicity of the radionuclides and inorganics would not be reduced. This technology would produce a secondary waste streams requiring treatment. This process option is estimated to have low to moderate effectiveness for reducing risks to human health and the environment and meeting RAOs at OU 9-04. This option would likely not significantly improve protection of human health and the environment at OU 9-04 sites. Impacts to human health and the environment could be minimized to allowable levels through administrative and engineering controls.

The implementability of this option is considered low to moderate. Costs are considered low to moderate relative to other ex situ treatment technologies. This option is screened from further consideration due to low effectiveness for soils with high percentages of fines (<150 mesh) common to ANL-W.

7.6.7.6 Chemical Stabilization. This option would consist of adding chemical amendments such as polymers, pozzolons, calcium, or sodium silicates or other amendments to excavated soils to produce a stable wasteform. This option alone would not reduce risks due to direct radiation exposure, which is the primary risk at most OU 9-04 sites of concern. Toxicity of the radionuclides would not be reduced; however, availability of radionuclides and exposure risks via soil ingestion and plant uptake would be reduced somewhat. No reduction in activity would occur; therefore, disposal of the wasteform in a low-level radioactive soil and debris landfill would be required. Reducing mobility of contaminants via leaching to groundwater, which is a primary benefit of stabilization would further reduce risks at OU 9-04. The volume of contaminated materials would likely increase.

This technology might potentially improve the effectiveness of separation technologies, by providing a stable waste form for disposal of relatively high concentration solids. This chemical stabilization is typically used on soils that fail TCLP analysis, because the mobility of the contaminants are reduced.

Impacts to human health and the environment could be minimized to allowable levels through administrative and engineering controls. The implementability of this option is considered moderate. Extensive handling and mixing of the soils would be required to produce a homogeneous wasteform. However, standard construction and soil handling equipment could be used. Treatability studies would be required to define correct amendments, concentrations, mixing times, etc. Costs would be low to moderate, relative to other ex situ treatment options.

This option is eliminated from further consideration due to its high costs, associated with stabilization are not justifiable for the ANL-W soils that do not fail the TCLP limits. Testing of the soils in the MCTBD have shown that the four inorganics that had the potential to exceed the TCLP limits, none exceeded the TCLP limits.

7.6.7.7 Thermal Treatment Using Plasma Torch. This option would consist of vitrifying excavated contaminated soils and debris at high temperatures to produce a stable, glass-like inert wasteform. No reduction in activity would occur; therefore, disposal of the wasteform in a low-level radioactive soil and debris landfill would be required. This option alone would not reduce risks due to direct radiation exposure, which is the primary risk at most OU 9-04 sites of concern. Toxicity of the radionuclides would not be reduced; however, availability of radionuclides, and plant uptake would be reduced. Reducing mobility via leaching and infiltration to groundwater, which is also a primary benefit of vitrification, would also reduce risks at OU 9-04. This technology might potentially improve the effectiveness of separation technologies, by providing a stable wasteform for disposal of relatively high concentration solids. However, it is unlikely that any INEEL soil fractions from separation processes would be of high enough activity to require stabilization prior to disposal. This technology therefore offers little improvement in effectiveness over excavation and disposal alone.

Plasma torch vitrification is planned to be demonstrated for treatment of Pit 9 materials at the INEEL, and may be part of the projected INEEL Advanced Mixed Waste Treatment Facility (AMWTF). Implementability of this option is considered uncertain, because the status of both the Pit 9 project and the AMWTF is currently uncertain. Otherwise, implementability is considered low due to the technical complexity of the plasma torch process. Impacts to human health and the environment during operations could be reduced to allowable levels through administrative and engineering controls. Costs would be moderate to high, depending on whether or not the capital construction costs of the melter were borne by all INEEL programs, or only by OU 9-04.

This option is screened from further consideration on the basis of low effectiveness.

7.6.7.8 Mercury Retort. This technology applies specifically to mercury-contaminated soils and sediments that fail, or are expected to fail, the RCRA TCLP test. ANL-W does not have mercury as a COC for any of the retained sites evaluated in the human health risk assessment. However, mercury is a COC for a

number of the sites contributing to the exological hazard quotients. The effectiveness of the retort method for other metals is poor.

Impacts to human health and the environment could be minimized to allowable levels through administrative and engineering controls. Technical and administrative implementability of this technology is considered moderate to high, based on previously implemented actions at the INEEL for soil treatment. Costs are relatively moderate. This option is screened from further consideration for OU 9-04.

7.7 Summary

Environmental monitoring process options retained include air, soil, and groundwater monitoring. Institutional control actions include fences, cap integrity monitoring and maintenance, deed restrictions, and surface water diversion. The representative excavation technologies are standard construction equipment including backhoes and dozers.

Containment options retained include the SL-1 type engineered barrier and the native soil cover. For purposes of this FS, the engineered barrier is the selected representative containment process option for radiologically contaminated soils and sites contributing to ecological risks. The native soil cover is considered to be acceptable for the Cs-137 contaminated soil, which is only needed to last 130 years, but not acceptable for the Ra-226 contaminated soil.

Disposal options retained include several low-level radioactively contaminated soil landfills. Unit disposal costs of \$400/yd³ are used for the representative low-level radioactive soil landfill disposal option in this FS. These costs represent current private industry costs, and are intermediate between unit costs for the RWMC (\$1770/yd³) and the WWP 1957 cell (\$50/yd³). Using intermediate costs produces less bias when distinguishing between alternatives on the basis of cost. Disposal at the WWP 1957 cell would impact subsequent selection of remedial alternatives for the WWP 1952 and 1957 cells and was therefore not identified as a representative process option. However, all of the landfilling options were retained through screening, and any could be selected in the ROD or during RD. If the projected INEEL soil repository were to be made available, this facility would likely be the most cost-effective and implementable option and could be selected. However, the status of this project is uncertain.

Because INEEL soils contaminated with Cs-137 cannot be treated effectively ex situ treatment options for excavated soils were evaluated primarily on the basis of their ability to reduce the overall volume of contaminated soils at OU 9-04 sites. Based on previous INEEL studies, no technology or combination of technologies has been demonstrated to be able to achieve significant volume reductions of contaminated TRA soils and sediments due primarily to the binding of cesium in both surface microfissures of large grained soil fractions, and in the silicate lattices of clay minerals of fine grained fractions. Grain size distributions of soils at ANL-W indicate that between 76 to 96 percent of the soils would pass through a 150 mesh screen. Because of the large percentage of ANL-W soil being the fines, the use of soil separation technologies to reduce the volume of the soil to be treated are not cost effective. The only in situ treatment option that was retained for further consideration is phytoremediation. The phytoremediation technology is retained because its costs are significantly less than the containment technologies and with a large percent of the soils at ANL-W being fines, may increase effectiveness of this technology. Phytoremediation is potentially

applicable to cleanup of both inorganic and radiologically contaminated soils depending on the selection of the plant species.

7.8 References

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